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ABSTRACT

A project was conducted to develop a curriculum in snowmobile repair and to determine if that curriculum was appropriate for snowmobile training programs in secondary schools throughout the state of Alaska. The completed curriculum was distributed by the Alaska Department of Education to snowmobile training personnel in the state. A stratified sample of 58 instructors across the state was surveyed to determine if the curriculum was being used or if it would be useful in the future, with 29 usable surveys returned. The results of the survey were subjected to a chi-square statistical test to determine if there existed a relationship between the usefulness of the curriculum and the community type served by the training program. Analysis of the data showed no statistically significant relationship between the usefulness of the snowmobile repair curriculum and the community type. The study found that the curriculum is appropriate instructional material for Alaskan snowmobile repair programs, regardless of the community type served. (A review of instructors' comments also led to corrections in the curriculum, which are included in this report.) (KC)

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# SNOWMOBILE REPAIR CURRICULUM USE BY COMMUNITY TYPE IN THE STATE OF ALASKA

Industrial Studies 298 Project Report
Presented to the faculty of the
School of Applied Arts and Sciences
Division of Technology
San Jose State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts in Industrial Studies

by
Stephen S. Hennessy
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Instructors across Alaska who participated in the project survey, for their comments and suggestions. I hope they will put the curriculum to good use.

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## Introduction

The purpose of this project was; 1). To co-author a curriculum in snowmobile repair, and 2). To determine if that curriculum was appropriate for snowmobile training programs in secondary schools throughout the state of Alaska.
The curriculum, *Snowmobile Repair* was distributed by the Alaska State Department of Education to snowmobile training personnel in the state. A stratified sample of fifty-seven instructors across the state of Alaska was surveyed to determine if the curriculum was being used, or if it was felt the curriculum would be useful to the program in the future. The results of the survey were subjected to a chi-square statistical test, with a significance level alpha equal to .05, to determine if there existed a relationship between the usefulness of the curriculum and the community type served by the training program.

This report covers background information on the development of the curriculum. The need for the snowmobile curriculum in the state of Alaska is discussed. Related research in vocational eduction in the state of Alaska is reviewed as to the differences in Alaskan communities and the effect these differences have on vocational education and implications to the design of this study. The survey method and study results are discussed.

### Curriculum Background

The curriculum, *Snowmobile Repair*, was originally written by Wayne Helbling and developed in 1976 for the Mid-America Vocational Curriculum Consortium, Inc., Stillwater, Oklahoma. The revised edition associated with this project was published in 1987. The consortium is an organization of eleven states which develops

instructional materials based on recommendations by a board of directors from the member states. Recommendations by the board of directors are based on a priority need by member states, and an attempt is made to revise existing curriculum every five years, if the material remains a priority.

The curriculum material is a competency-based vocational curriculum. Each curriculum publication, such as the *Snowmobile Repair* curriculum, is divided into instructional units consisting of the following eight components:

1. Unit objectives and specific performance objectives state the student performance necessary to reach the unit objective.
2. Suggested activities provide a basis for lesson planning. These include; mandatory and optional activities, an outline listing of the contents of the unit, references used in the unit, and suggested supplemental references and audio visual aids.
3. Information sheets provide the essential content of the unit. They serve as a guide for meeting the cognitive objective of the unit and provide the instructor with an outline format for presenting the background knowledge needed to master the performance objectives of the unit.
4. Transparency masters, when appropriate, serve to illustrate items presented in the information sheets.
5. Assignment sheets allow students to apply cognitive learning described in the information sheets. These are a pencil and paper exercise presenting problem solving situations where the students must apply information presented in the unit. Answer sheets are provided for each assignment sheet.
6. Job sheets provide the psychomotor element of the unit. Job sheets include a tool and material list and a procedural outline for the student to follow in accomplishing the specific skill.

7. Evaluation is provided in both written and performance tests. Tests are constructed to measure student achievement of each objective listed in the unit of instruction.
8. Test answers are provided for each unit. These may be used by the teacher or the students to evaluate student achievement of the unit objectives.

The competency based curriculum format is designed to provide instructors with a useable guide to instruction. Instructors are encouraged to add objectives to the units of instruction and use additional instructional activities and teaching methods to assist the student in accomplishing the unit objectives. The dynamic format of the curriculum allows many of the units of instruction to be used out of sequence by instructors to meet the needs of their setting. The curriculum material could be used by students in an individualized open entry/open exit instructional setting or as a course of study for comprehensive course of study following the unit sequence.

When the original *Snowmobile Repair* curriculum was written, the snowmobile industry was experiencing tremendous growth. Twenty-one snowmobile manufacturers in 1970, producing half a million snowmobiles, had grown to seventy-five manufacturers in the mid-1970's (Glitz, 1981). Due to a slump in the snowmobile industry in the early 1980's, the current snowmobile industry is survived by only four major snowmobile manufacturers. Due to technological advances in the industry, and changes in snowmobile design among the remaining four snowmobile manufacturers, the 1976 curriculum was not representative of current industry standards. *Snowmobile Repair* would not have been revised by the consortium if the state of Alaska, in 1986, had not provided supplemental development funding. The state of Alaska, though not a member of the Mid-America Vocational Curriculum Consortium, Inc., had determined that snowmobile repair curriculum was a viable need in the

state's vocational programs. *Snowmobile Repair*, published in 1987, was a complete rewrite of the original curriculum. The addition of many new units that did not appear in the original text, and attention to changes in the snowmobile industry, make the new curriculum a more comprehensive and useful publication.

Curriculum Need in the State of Alaska

The need for snowmobile repair curriculum in the state of Alaska is substantiated by factors including;

1 The local use of a vehicle so aptly suited to the terrain and climate of the state.

2. An indicated need of vocational instructors involved in training students across the state.

3. Snowmobile sales and employment figures in the state.

The snowmobile, despite the industry slump in the lower forty-eight states, still serves a major role in recreational and everyday transportation in many communities in the state of Alaska. In a state which covers an area of one-fifth that of the continental United States, with only five-hundredths of one percent not wilderness (The Alaska Almanac, 1988), there is great potential for the snowmobile's use. The state has less than 14,000 miles of paved or gravel roads, concentrated in and between the two main population centers of Anchorage and Fairbanks. The limited network of roadways is further illustrated when compared to Alaska's 33,904 miles of coast line, more than all of the continental United States coasts combined (Grieser, 1973). Many communities in the state are not connected to the limited network of roads. They depend on alternative modes of local transportation, the snowmobile being one form. The climate of the state allows the use of snowmobiles in many communities from early October until late May.

The need for current snowmobile repair curriculum material is best substantiated by the expressed need of vocational training programs in the state. The state of Alaska is served by 55 public

school districts with a total state enrollment of just over 103,000 students. A curriculum information mailing (Jackson, 1987) conducted by the Office of Adult and Vocational Education, surveyed districts for their needs of vocational education curriculum in various program areas. The curriculum information mailing indicated 79% of the small engine repair programs in 28 districts across the state were requesting curriculum information for snowmobile repair programs. These 28 districts ranged in student enrollments of under one hundred to the largest of nearly forty thousand. A study conducted in 1978 (Northern Institute for Research, Training and Development, Inc.) further indicates the need for usable curriculum material by the vocational educator in the state. The study rated planning and evaluating units of instruction as the highest priority for training needs of vocational educators in the state of Alaska.

The state employment statistics are a less helpful indication of the need for curriculum in the field of snowmobile repair than are the sales figures for the state of Alaska. The Alaska Department of Labor lists seventy-two small engine specialists employed in the state (Alaska Department of Labor, 1986). This employment figure is projected to increase to seventy-nine by 1990. Accurate sales figures for new snowmobiles in Alaska were difficult to obtain. A phone survey of major snowmobile distributors for the state yielded a 1987-1988 state-wide sales figure of 3,000 to 4,000 units, some distributors considered their sales figures proprietary which likely skewed this estimate. The International Snowmobile Industry Association (ISIA) estimates 1800 new snowmobiles were sold in Alaska during 1987-1988 (Ahern, 1988). The 1980-1981 season was the last year the ISIA tabulated state-by-state sales records, during which Alaska had a sales figure of 3900 units. One major state distributor estimated that sixty percent of their sales occurred outside of the Anchorage urban area where authorized dealer service may not be available.

In comparison, the state has a 1987 sales figure for new automobiles and trucks of 20,904. The number of automotive mechanics in the state, according to the State Department of Labor is 1,247. Comparing mechanics per new vehicles sold in 1987, there are 16.8 new autos sold per mechanic compared to 25 to 50 new snowmobiles sold for each mechanic employed to service them. This may indicate a discrepancy between the two industries. These figures may indicate that much of the maintenance for snowmobiles is carried out by individuals who are not regularly employed as a small engine mechanic and do not appear in the employment statistics of the department of labor.

It should be emphasized that a large portion of the snowmobile sales are in the bush and village communities where snowmobiles are used daily as an important mode of transportation. It is in these remote communities where authorized dealer service may not be available, and the greater need may exist for training the local residents in the repair and maintenance of snowmobiles. The local and regional importance of small engine repair training is pointed out in two studies conducted in Alaska. One study conducted to evaluate Alaska's small rural high schools (Kleinfeld, Judith, and Others, 1985) indicates that a successful strategy for providing vocational education in Alaska's small rural schools is to teach "local practical skills, like small engine repair" (p. 32). Walsh (1978) lists small engine repair and snowmachine repair training as a frequently offered significant course in many of the small remote bush/village communities "because of reliance upon snowmachines and small boats as a means of transportation" (p.6).

Related Research

The majority of research in vocational education issues in Alaska is of a broad scope and does not focus on specific curriculum needs or curriculum use in areas related to the snowmobile repair industry. Many of the previous studies

reviewed during this project dealt with the overall needs of vocational education or vocational educators in the state. Despite the broad scope, existing literature does provide a basis for the objective of this study. Existing literature does indicate vocational educational needs and the success of vocational training vary within community types across Alaska.

Walsh (1978) makes reference to "regional differences in economics, cultural backgrounds, accessibility, and community size" (p.2) affecting vocational education resources in different regional units across the state. Though it was not the intent of Walsh's report to compare region against region, local conditions are cited as a concern in recommendations for vocational education planning and evaluation. The limited size and resources of many remote communities in Alaska is cited by Barnhardt, et al. (1979) as a condition making it "...impossible to offer the variety of programs and other learning opportunities available in a large urban high school facility" (p.52). Evidence exists showing student achievement is affected by school size and geographic area in Alaska. Alaska Statewide Student Assessment (1980) in a survey of eighth grade test scores states "students in large and medium sized districts performed better than those in small and rural districts" (p.28).

Kleinfeld et al. (1985) presents a contradictory view to the 1980 state-wide assessment study in a survey of small rural high schools, reporting high school size does not determine the quality of students, educational experiences, or achievement on standardized tests. The report does, however, identify vocational education as "the single weakest area of small high schools. Difficulties in providing effective vocational programs in small rural high schools extend beyond the lack of specialized vocational education teachers and essential equipment" (p.30). The lack of adequately trained vocational teachers in small rural schools is also pointed out by a 1984 report to the governor of Alaska (Alaska Commission on Postsecondary Education [ACPE], 1984).

This report to the governor disputes the myth that problems of vocational education affect both urban and rural schools equally; "Without diminishing the very real problems present in urban areas, a great deal of evidence suggests that major problems exist in the rural areas. These problems are especially acute in the smaller secondary schools" (p.9). The report, however, fails to identify specific problems related to vocational education in Alaska.

Additional variables affecting the delivery of vocational education are evident in the basis for state school funding. Many communities in Alaska receive the majority of their school operating budget from the state rather than from local revenue contributions. The state funding of education is adjusted for geographical location and for disparity in local tax bases. Livey and Keiser (1987) report, "Some districts--most notably rural districts with limited tax bases-- have been funded entirely by the State while others have raised local taxes to supplement State support" (p.9). Chambers and Parrish (1984) cite, "such factors as climate, degree of isolation, cost of living, labor market conditions, cultural amenities, access to retail and service trade establishments..." (p.7) are variables which affect the cost of providing education in remote areas of the state. Not only would the above factors affect the cost of general education in different communities, these factors would have an influence on the effective operation of vocational education programs which traditionally rely on support from local community and industry resources. If remote communities are lacking a retail and service trade industry, or are isolated from centers of commerce and trade, the vocational education programs would likely be adversely affected in comparison to schools with more ready access to such resources.

Community Types

The objective of this study was to explore the relationship between the usefulness of the *Snowmobile Repair* curriculum and the community type which the training program served. Variables in communities which may affect vocational education programs and hence have some effect on the usefulness of the *Snowmobile Repair* curriculum have been pointed out in the review of the related research. Some of these variables include; community size, cultural differences, degree of isolation, and distance from centers of retail and service trade establishments. The related research provided no consistent classification of community types which were meaningful to the objectives of this study. Many studies divide the state into regions. However, regional divisions do not correlate to the identified variables. Livey and Keiser (1987) point out, "Every region of the state contains a school district with fewer than 200 students and more than 1,000 students" (p.107). The most frequent terms used in the literature are urban and rural. The literature differs in the definition of these terms. Kleinfeld et al. (1985) define a small rural high school as having fewer than 100 students and located in communities of fewer than 1,000 residents, while a report from the Alaska State Department of Education (Guidelines for Developing, 1978) defines a small rural secondary school as "any educational institution in rural Alaska serving one to 50 students" (p.6). A different definition is provided by another study conducted by the Alaska State Department of Education (Alaska Statewide Student, 1980); A rural school is defined as any of the schools served by the Regional Education Attendance Areas (REAA). REAA are school districts located in either unorganized boroughs previously under the management of the former state operated school system or the Bureau of Indian Affairs. Student enrollment in the REAA's vary from under 100 to over 2500 (Facts & Figures, 1987).

Due to the absence of an existing definition of community types convenient to the objectives of this study, the following four community types were proposed; 1). Bush, 2). Village, 3). Rural, and 4). Urban. For the purpose of this study the following definitions are presented for these community types:

Bush- A remote community not accessible by road, and typically further than 200 air miles from an urban center with a typical population of under 500.

Village- Alaska Native village as identified by the Bureau of Indian Affairs and the Alaska State government and listed in the 1980 Census of Population for American Indian Areas and Alaska Native Villages (1984). Population ranging from under 100 to 4000, with a typical population of 300 to 600.

Rural- An Alaskan community which is usually accessible by the road or ferry network and with a population between 1000 and 3000. These communities have economical access to the urban centers and in a few cases ( Nome and Dillingham) are major airport hubs for large remote areas.

Urban- The major metropolitan and commercial centers of the state, including; Anchorage, Fairbanks, Juneau, and Ketchikan, and those communities within daily commuting distance from these urban centers. Population ranges from 10,000 to over 200,000 in Anchorage.

The decision to divide remote community types into bush and village categories was to provide identification for non-native remote communities. In the analysis of the target population and survey data, there was not a significant number of non-native

bush communities to warrant these separate categories. Analysis of the target population by bush communities showed that all of the surveyed remote communities had a native population of 60% or greater (Ender, 1980). Because of these similarities, the bush and village categories were combined into one category; bush/village for the statistical analysis of the data.

Hypothesis

The apparent differences among community types in Alaska and their influence on effective vocational programs provide the basis for the hypothesis of this study. The null hypothesis and research hypothesis are stated as follows;

> Null hypothesis: There is no relationship between the usefulness of the *Snowmobile Repair* curriculum and the community type which the training program serves.
>
> Research hypothesis: The usefulness of the *Snowmobile Repair* curriculum is related to the community type which the training program serves.

The literature points out numerous differences among community types in the state and the potential for community type, particularly the bush/village communities, to adversely affect vocational education programs. The question asked by this study is; Does the community type have an effect on the usefulness of the *Snowmobile Repair* curriculum? It was not the intent of this study to conduct an exhaustive analysis of the variables among community types. This study wishes to only determine if the *Snowmobile Repair* curriculum is appropriate for all the snowmobile repair programs in the state regardless of the community type served. If the research hypothesis is supported by the data, it will indicate that further study may be warranted to determine curriculum changes needed to better serve selected

communities. If the null hypothesis is supported, it may indicate that *Snowmobile Repair* is appropriate instructional material for Alaskan snowmobile repair programs, regardless of the community type served.

## Method

### Survey Instrument

The survey instrument (see Appendix A) was comprised of seven items. Question types included forced-choice, rank-order, and open-ended. Survey questions concentrated on items necessary to the study objectives and avoided unnecessary or sensitive questions. The survey was designed as a single page instrument to make it easy to complete and encourage a high response rate.

Student enrollment information provided by the Office of Adult and Vocational Education revealed districts may list Small Engine Repair as an approved course, however, the course may not be taught every enrollment period. This information indicated that snowmobile repair was not taught by many schools on a continual basis. It was because of this fact that the survey instrument asked if the *Snowmobile Repair* curriculum had been used in the respondent's training program, and if not, based on a review of the curriculum, did the respondent feel the curriculum would be useful to the training program. The survey instrument was designed to gather data by community type from both the instructors who had used the curriculum and from those who had reviewed the curriculum, but not had an opportunity to use it.

### The Population

The target population was finite; those small engine repair programs in the state of Alaska that included or planned to include snowmobile repair in the course of study, and those that were using, or planned to use, the *Snowmobile Repair* curriculum. Since the target population was small, this project attempted to survey as much of the population as could be identified. The

1987-1988 enrollment reports provided to the Office of Adult and Vocational Education by school districts in the state of Alaska (Cox, 1988) listed 30 school districts offering courses in small engine repair at 48 school sites. It should be noted that the information provided to the Office of Adult and Vocational Education does not indicate if a small engine repair program offers snowmobile repair as a segment of the curriculum. The listing of small engine repair programs in the state was used as the basis for determining the distribution by community type for the stratified sample of snowmobile repair programs. Table 1 lists the distribution of all small engine repair programs in 1987 and 1988 by community type.

Table 1

Distribution of Small Engine Repair Programs by Community Type

| Community Type | Number of Small Engine Repair Programs State-Wide 1987-1988 | Percentage |
|---|---|---|
| Bush/Village | 27 | 56% |
| Rural | 11 | 23% |
| Urban | 10 | 21% |
| Total | 48 | 100% |

## Procedure

The response to the 1987 curriculum information mailing (Jackson) conducted by the Office of Adult and Vocational Education, which surveyed all Alaskan districts for vocational education curriculum needs, was initially used to identify the target population. Twenty-eight of the thirty school districts that offered small engine repair courses responded to the curriculum information mailing indicating a need for curriculum information

for 38 snowmobile repair programs. The Office of Adult and Vocational Education distributed copies of the *Snowmobile Repair* curriculum to these 38 snowmobile repair programs. A cover letter (see Appendix B), a survey instrument , and a stamped return envelope were mailed to the 38 snowmobile repair programs identified in the 1987 curriculum information mailing. A 47% response rate was realized in the return of eighteen surveys. The response was determined not adequate for meaningful analysis. The survey mailing was conducted in May, 1988, and no follow-up mailing was attempted until the following fall due to the ending of the school year. The initial mailing to 38 snowmobile repair programs had a distribution by community type of; bush/village-65%, rural-21%, and urban-13%. This distribution resulted in an over-representation of bush/village communities and an under-representation of urban communities.

In September, 1988, the University of Alaska offered a vocational technical workshop for instructors of snowmobile repair programs. This workshop was designed to provide instruction in snowmobile repair for instructors who were planning to teach snowmobile repair as well as for instructors who were currently offering a course in snowmobile repair. The workshop informational mailer was sent to all school district vocational directors and all secondary trade and industry vocational instructors in the state of Alaska. Twenty-one instructors from various communities across the state enrolled in the workshop on a first come first serve basis. Four communities represented by the workshop participants were included in the original survey mailing in May, 1988. However, only one individual enrolling in the workshop was included in the original survey mailing conducted in May, 1988. Twenty of the twenty-one participants in the workshop represented new additions to the target population for this study. All participants in the snowmobile repair workshop were provided a copy of the *Snowmobile Repair* curriculum.

The 38 instructors responding to the 1987 curriculum information mailing and 20 additional instructors who attended the September, 1988 snowmobile repair instructor seminar conducted by the University of Alaska, Anchorage, account for the 58 instructors surveyed by this project as to the usefulness of the *Snowmobile Repair* curriculum. The addition of the 20 participants of the snowmobile workshop provided a needed addition to the target population for the study. These 20 new members produced a distribution of the sample population (see Table 2) which was surprisingly similar to the distribution of small engine repair programs state-wide. Because the distributions were so similar and the population and sample were small, no attempt was made to randomly select members for the survey. All 58 instructors were sent surveys.

A cover letter (see Appendix C), survey instrument, and a stamped return envelope were mailed to the 20 instructors who attended the snowmobile repair workshop. A follow-up cover letter (see Appendix D) and additional survey instrument with a stamped return envelope were mailed to the non-respondents from the May 1988 survey mailing. A follow-up post card (see Appendix E) was mailed approximately three weeks later. A total of 38 instructors responded to the survey, yielding a 66% response rate. Table 2 lists the number of surveys sent and their distribution percentage by community type. The figures under the response column list the number of surveys returned by community type and the distribution percentage of the response compared to the 38 total surveys returned.

Table 2

Survey Distribution and Response Rate by Community Type

| Community Type | Surveys Sent Number (Percent) | Response Number (Percent) |
|---|---|---|
| Bush/Village | 33 (56.9%) | 21 (55.3%) |
| Rural | 13 (22.4%) | 8 (21%) |
| Urban | 12 (20.7%) | 9 (23.7%) |
| Totals (Percent) | 58 (100%) | 38 (66%) |

## Results and Discussion

Of the surveys received, only twenty-nine (50%) were included for hypothesis testing. Nine surveys were not included for hypothesis testing because the respondents had not received a copy of the *Snowmobile Repair* curriculum or the curriculum was not applicable to their course (e.g.,welding). Of the surveys excluded from hypothesis testing, six where from bush/village communities, two from rural communities and one was from an urban community. The distribution of surveys by community type used for hypothesis testing was as follows; bush/village communities-51.7%, rural communities-20.7%, urban communities-27.6%. This distribution varied from the population distribution causing the bush/village and rural communities to be under represented and the urban community to be over represented (see Table 1 for comparison).

The data obtained from the survey instrument was analyzed in two contingency tables. One contingency table tested the relationship between community type and curriculum use (see Appendix F). The second contingency table tested the relationship between community type and the anticipated usefulness of the curriculum (see Appendix G). A chi-square value with a significance level alpha equal to .05 was computed for the data in each of the two tables. A chi-square value of .97 was calculated for the relationship between community type and curriculum use. A chi-square value of 1.14 was calculated for the relationship between community type and the anticipated usefulness of the curriculum. Both values show that there is no statistically significant relationship between the usefulness of the *Snowmobile Repair* curriculum and the community type which the training program served.

The use of the chi-square analysis for this data may be questioned since some of the expected frequencies in the contingency tables are small. This is attributed to the small sample size. When expected frequencies are smaller than what is considered statistically safe (Leabo, 1976), the Yate's correction may be used. The Yate's correction was applied to this data and the result had no effect on the decision statement.

The analysis of the data indicates that the *Snowmobile Repair* curriculum is appropriate instructional material for Alaskan snowmobile repair programs, regardless of the community type served. This is a positive statement for the curriculum design given the many differences among Alaskan communities and the potential pointed out in the literature for these differences to adversely affect vocational education programs. Perhaps the organized format provided in the Mid-America Vocational Curriculum Consortium material and the dynamic nature of the curriculum allow instructors to easily utilize the components of the curriculum which best suit the community type served.

The survey data indicates that 72% of the instructors, when surveyed, had not used the curriculum. Over half (59%), however, felt the curriculum would be very useful to their snowmobile repair programs, and the remaining 41% indicated that the curriculum would be somewhat useful. Other than the comments provided by the respondents (see Appendix H), the survey provided no method to measure what variables in the different communities influenced whether or not the curriculum was being used. The discrepancy between the number of instructors who had actually used the curriculum and those who felt it would be very useful may be due to snowmobile repair classes not being offered on a continual basis in many school districts. Some respondents commented that their school did not have a snowmobile repair program at the time of the survey, but were scheduled to begin teaching the curriculum in coming semesters.

Some respondents commented that the reading ability of the students in the community was "low" and the students experienced difficulty understanding industry repair manuals and may have difficulty with the information sheets and tests in the *Snowmobile Repair* curriculum. The Alaska Statewide Student Assessment (1980) indicated evidence of reading problems among bilingual students in bush/village communities. An evaluation of reading level of the *Snowmobile Repair* curriculum was performed using the Fry Readability Scale (Fry, 1978). The Fry Readability Scale rated the *Snowmobile Repair* curriculum at a 9th grade reading level.

The purpose of this project as stated in the introduction was; 1) to co-author a curriculum in snowmobile repair, and 2) to determine if that curriculum was appropriate for snowmobile training programs in secondary schools throughout the state of Alaska. Since the completion of the curriculum, review of the material has indicated the need for corrections. Appendix I contains corrections which conform selected terminology to industry standards, provide cautionary notes for procedures outlined in the curriculum job sheets, and correct minor mistakes found in the original material. These corrections are intended to be used by the instructors in the field to update the *Snowmobile Repair* curriculum. The curriculum corrections bring the first component of this project to completion. Addressing the second component of this project, the survey and analysis of gathered data indicated that while there was no statistically significant relationship between the usefulness of the curriculum and community type, only 29% of the programs surveyed had used the material. The discrepancy between the number of instructors who had actually used the curriculum and those who felt it would be very useful (59%) raises questions concerning variables not addressed by this study.

Curriculum is only one component of an effective vocational education program. The *Snowmobile Repair* curriculum format

and content received favorable reviews by the majority of instructors' survey comments. The curriculum appears adaptable to varying instructional settings across the state. Other issues found in the survey comments indicate a need for instructor training, increased funding, industry support, and programs which address local needs.

During the project, it was found that an effective communication network is lacking in the state of Alaska between instructors in the classroom, the State Department of Education and industry contacts. This problem is most acute in the bush/village school sites. Most schools in these remote sites are administered by district offices far removed from the classroom and correspondence routed through district offices many times does not reach the classsroom teacher. Another concern in bush/village school sites is many instructors are called on to teach multiple vocational disciplines. Methods must be found to effectively in-service these teachers, enabling them to teach in varying technical fields in which they may have little or no background.

A concern affecting program in urban as well as bush/village school is industry contact and support for vocational programs. Instructors need to be trained and encouraged to develop strong industry advisory committees for local vocational programs. These industry resources need to be regularly utilized to strengthen the curriculum and guide the program to meet local needs.

Organizations and institutions serving vocational educators in Alaska should continue their efforts to evaluate vocational education and address indicated needs in the effort to improve programs in Alaska.

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# APPENDICES

# Appendix A

## Snowmobile Repair Survey

Name_____
Address_____
_____

| | Circle Response |
|---|---|
| 1. Which best describes the community which your school serves? | bush<br>village<br>rural<br>urban |
| 2. Did you receive a copy of Snowmobile Repair curriculum from the Alaska Vocational Materials Library? | yes no |
| 3. Have you used the curriculum as part of your instructional program? | yes no |
| 4. If you have not used the curriculum this past year, have you reviewed the material? | yes no |
| 5. Do you feel this curriculum will be useful to your program? | very useful<br>somewhat useful<br>not useful<br>not applicable to program |

6. Please indicate the contents of the curriculum which you found most valuable, e.g.Information Sheets, Transparency Masters, Assignment Sheets, Job Sheets Tests.

_____
_____
_____
_____
_____ please use back of page if needed

7. Please indicate any shortcomings of the curriculum or suggestions to improve the curriculum for your teaching location.e.g... Is the curriculum appropriate for the type of snowmobile your program services? Are you able to obtain necessary vehicle manuals and special tools? Is the curriculum too basic, or not detailed enough?

_____
_____
_____
_____
_____ please use back of page if needed

## Appendix B

### Survey Cover Letter #1

May 16, 1988

Dear Colleague:

This past winter the Office of Adult and Vocational Education in Juneau should have sent you a copy of Snowmobile Repair. Snowmobile Repair was developed by the Mid-America Vocational Curriculum Consortium (MAVCC) with my assistance and financial support from the State of Alaska.

My efforts in rewriting this curriculum served as a portion of a Master's of Arts Degree in Vocational Education. I hope to finish my degree requirements this summer and I am asking for your help.

Please take a minute and complete the enclosed survey. Your response will be included in a study I am conducting to determine if this type of instructional material is being used successfully in Alaska. (A survey from Juneau was included with the curriculum, this is a separate effort on my part and I hope you will take a moment to respond). **Please return the survey by June 1, 1988.**

Without your response, I can not complete my study and my final Master's Project will be in jeopardy. Please use the enclosed addressed and stamped envelope and return the survey as soon as possible.

For those of you who respond, I will forward a copy of the survey results and a packet of corrections for the Snowmobile Repair Curriculum which I have compiled.

Thanks, and have a good summer;

Stephen S. Hennessy

Enclosures.

Appendix C

Survey Cover Letter #2

October 22, 1988

Dear Colleague:

This past September you were involved in a snowmachine repair clinic. I provided you a survey in reference to the curriculum Snowmobile Repair which was given to you as part of the clinic's information. I have included a copy of the survey and a stamped addressed envelope.

Please take a minute and complete the enclosed survey. Your response will be included in a study I am conducting to determine if this type of instructional material is being used successfully in Alaska. **Please return the survey at your earliest convenience.**

Without your response, I can not complete my study and my final Master's Project will be in jeopardy. Please use the enclosed addressed and stamped envelope and return the survey as soon as possible.

For those of you who respond, I will forward a copy of the survey results and a packet of corrections for the Snowmobile Repair curriculum which I have compiled.

Thanks, and have a good school year.

Stephen S. Hennessy

Enclosures

Appendix D

Follow-up Survey Cover Letter

October 22,1988

Dear Colleague:

This past spring I mailed you a survey in reference to the curriculum Snowmobile Repair, which was sent to you last winter according to the Office of Adult and Vocational Education in Juneau.

Please take a minute and complete the enclosed survey. Your response will be included in a study I am conducting to determine if this type of instructional material is being used successfully in Alaska. **Please return the survey at your earliest convenience.**

Without your response, I can not complete my study and my final Master's Project will be in jeopardy. Please use the enclosed addressed and stamped envelope and return the survey as soon as possible.

For those of you who respond, I will forward a copy of the survey results and a packet of corrections for the Snowmobile Repair Curriculum which I have compiled.

Thanks, and have a good school year.

Stephen S. Hennessy

Enclosures

## Appendix E

### Follow-up Post Card

Last week a survey was mailed to you seeking your feedback on the curriculum **Snowmobile Repair.** Your name was chosen as one who had received the curriculum from the State Department of Education last winter, or had attended a fall seminar in snowmachine repair in Anchorage.

If you have not completed the survey, please do so today. Since the survey was only sent to a small group of instructors in Alaska, your response is very important. If you have completed and returned the survey, please accept my sincere thanks. Your response will be valuable to the study.

If you need another survey please call me today; 907-376-5341. Thanks, Stephen S. Hennessy. 11-12-88

## Appendix F

### Contingency Table: Community Type-Curriculum Use

| Community Type | Curriculum Used | Curriculum Not Used | Totals |
|---|---|---|---|
| Bush/Village | 3 | 12 | 15 |
| Rural | 2 | 3 | 5 |
| Urban | 3 | 6 | 9 |
| Totals | 8 | 21 | 29 |

Significance level alpha = .05 chi-square = .97

## Appendix G

Contingency Table: Community Type-Anticipated Usefulness

| Community Type | Very Useful | Somewhat Useful | Totals |
|---|---|---|---|
| Bush/Village | 8 | 7 | 15 |
| Rural | 4 | 1 | 5 |
| Urban | 5 | 4 | 9 |
| Totals | 17 | 12 | 29 |

Significance level alpha = .05 chi-square = 1.14

## Appendix H

### Comments of Survey Respondents

Comments in Response to Survey Item #6 by Community Type

As an outline relating to snowmobile repair, the material provides good guidelines for a subject not covered in available texts. Material of this type provides a course of action to follow...compared to trying to teach a course for which you must make up and organize material as you go along.-bush/village

I haven't used the curriculum, but I have looked through it. It would be very helpful to have a program here, because snowmachines are the main transportation during winter here in our village. I have talked to our principal about teaching the course one of the semesters, but nothing has been done.-bush/village

Very well done.-bush/village

The entire curriculum is very useful. There was no specific curriculum for snowmobiles at this school. I feel it will be very helpful.-bush/village

Good job.-bush/village

If I were teaching a class in snowmobile repair I would use this layout. It is very close to what we use in auto shop now. It is very good.-bush/village

This material is long overdue. All of the information appears to be very good. I wish I had something like this when I taught snowmobile classes in the past.-bush/village

Assignments sheets , job sheets, and test really help provide direction for the students.-bush/village

I have not used it yet.-bush/village

Comments in Response to Survey Item #6 continued.

The information sheets provide an easy outline of information and are very easy to use. Items such as transparency sheets or ditto masters of important information are always handy for a busy teacher.-bush/village

I have not used this material this year due to the fact that I have not offered a small engine course.-bush/village

I like the whole set-up.-bush/village

I used some parts of the manual for instruction. We don't have a shop or a place to work so most of what I used were the transparency masters for lecture.-bush/village

Information sheets were used the most.-rural

Overall the format was very good. The tests were the most helpful.-rural

Assignment sheets, Job sheets and test (were most helpful).-rural

Assignment sheets and test were most valuable.-rural

It is nice to see a complete curriculum with tests, assignment sheets, etc. I don't get into snowmachine repair much in my classes but I can use the material. Well done.-urban

Have not been able to try the curriculum yet, will be using it this winter.-urban

Useful, well laid out, and organized.-urban

We are just starting a small engine program. This material will be very useful in the future. Good material. I have used the MAVCC material before, the best available. I hope all curriculum material in the future is the same.-urban

Comments in Response to Survey Item #7 by Community Type

The reading levels of the students here is low. I believe they would have trouble with the test and information sheets. The life of many snowmobiles out here is greatly shortened by lack of maintenance coupled with abuse. I would like to see a section which addresses both of these.-bush/village

We have not had a small engine course previously. Scheduled to start second semester this year. More detailed information would help.-bush/village

I use factory service manuals in shop. We have what we need as a general rule.-bush/village

I think the material is fine. More specific detailed information for a certain machine would be nice, but quite unrealistic, if not impossible, to develop. This material looks like it will adapt to many situations quite well. I hope to be able to use it soon.-bush/village

Not having used the curriculum yet I can't comment on the drawbacks. For a small school, the biggest problem we face is lack of vocational education funding. It is difficult to buy the necessary special tools needed.-bush/village

Being a small rural school, one teacher covers all areas; woods, building trades, small engines, auto, and welding. Information need not be too detailed and quick and easy to use. It is not possible for one teacher to become expert in repair of all snowmobiles, but a little basic knowledge is worthwhile and needed very much.-bush/village

This material looks very appropriate, and I am looking forward to using it. This material is much better than anything I have on the subject including several service manuals which are almost impossible for my students to decipher.-bush/village

Comments in Response to Survey Item #7 continued.

I teach two-week courses in small engine preventive maintenance, troubleshooting, and repair. I have used bits and pieces of the material and have liked it.-bush/village

It looks to be a good guide. There always seems to be some difficulty in obtaining parts and special tools out here. I would definitely use this guide if I ever have a "real" class in repair.-bush/village

Please send for review.-bush/village

Please send a copy ASAP.-bush/village

If this curriculum was just for a special class just on snowmachines it would be excellent. I tried to fit it into my small engine class and in doing so had to condense it. Combined with teaching basic engines and shop studies, the snow season was almost over before I got through a condensed version. The tests are too dependent on the information sheets.-rural

The curriculum which we received could have been more detailed and could have covered more specific items; timing for CDI, timing for points etc.. Could have a chart for different snowmobile tune-up specifications.-rural

I think this is the best teaching device I have found for snowmobiles. When my curriculum can include a unit on snowmachines I will use the material.-rural

Need more information on specific snowmobiles, and my program is lacking needed factory repair manuals for repair specs.-rural

The curriculum is very good but need more input from other makes of snowmobiles.-urban

Comments in Response to Survey Item #7 continued.

I don't get into snowmachine repair at my school. We just cover four stroke small engines in detail in our beginning level class. There is a second year class that I could offer but because of staffing and space limitations I haven't taught it in the past seven or eight years. If I do, I will use this as an integral part of my instruction.-urban

It is my opinion that the curriculum, as a whole, is written at a much lower level than should be taught at the secondary level of education. Too much effort is spent on basics with no hint of the idiosyncrasies of snowmobiles (e.g. the effects of temperature and altitude on engine performance, clutch adjustment, and changes necessary in carburetion and clutch tuning to maintain proper performance and/or avoid costly repairs).-urban

Cost prevents program from buying a lot of the necessary manuals and special tools. A lot of the job sheets are not applicable because we do not have all types and models of snowmobiles. Sled (snowmobile) parts seem to be hard for me to get. The manufactures do not seem to want to help.-urban

# Appendix I

## Curriculum Corrections

Contents:

Preface

Green Correction Page 1, 2, 3, 4.

Blue Correction Page 1, 2, 3.

Pink Correction Page 1, 2.

Yellow Correction Page 1, 2.

## Preface to Snowmobile Repair Curriculum Corrections

The following pages are corrections to the curriculum publication:

> Snowmobile Repair, Written by Stephen S. Hennessy and Rex Conrad, edited by Dan Fulkerson, developed and published by The Mid-America Vocational Curriculum Consortium, Inc., Stillwater, OK. (1987).

The corrections to the curriculum are comprised of eleven pages:

> Green Correction Page 1, 2, 3, 4.
>
> Blue Correction Page 1, 2, 3.
>
> Pink Correction Page 1, 2.
>
> Yellow Correction Page 1, 2.

The corrections are intended to be **cut out and pasted** to the curriculum publication, allowing instructors in the field to update their existing curriculum until a revised edition is published.

**Correction entries should be cut out between page number headings and pasted to the appropriate location in the curriculum on the page number preceding the correction entry.**

The correction pages have been color-coded to correspond to the color scheme of the curriculum publication. The correction entries have been ordered on odd-and even-numbered pages to correspond with left-facing and right-facing pages of the curriculum publication.

These correction pages have been authored by Stephen Hennessy in an attempt to correct minor mistakes found in the curriculum, conform selected terminology to industry standards, and provide cautionary notes for procedures outlined in the job sheets. These corrections are not distributed or endorsed by the Mid-America Vocational Curriculum Consortium, though the author hopes they will be considered when the curriculum is revised.

PAGE SR-9, VII. **Snowmobile engine systems**

B. Other systems and components of a snowmobile engine include:

1. The carburetor
2. The cooling system
3. Ignition system and spark plugs
4. Carburetion and fuel system
5. Lubrication system (pre-mix or injection system)
6. An exhaust system

PAGE SR-205, I **Terms and definitions**

A. Drive axle - A solid or semi-solid shaft of steel which connects to the drive chain by a sprocket and drives the track.

PAGE SR-255, I **Terms and definitions**

G. Rods - Steel rods (early models) or fiberglass rods (latter models) molded into the track to make it rigid and give the track strength.

PAGE SR-319, V. **Maintenance**

C. Self-adjusting disc brakes use a ratchet mechanism to maintain proper pad clearance.

(NOTE: The ratchet mechanism is activated by normal braking operation, and the only other adjustment usually needed is cable free play.)

PAGE SR-351, **Guidelines for engine service**

Add the following below item XII. G.

H. Liquid-cooled snowmachine engines should have the cooling system and reservoir tank cap pressure tested. Do not exceed recommended pressure, usually equal to pressure rating stamped on the tank cap.

I. Inspect exhaust system for proper mounting, sealing, cracks or damage to exhaust system components.

(NOTE: Do not leave ethylene-glycol in open containers where pets or small children may drink the solution. A few sips can be deadly.)

PAGE 70, III Power theory
Replace the note below item D. with the following:

(NOTE: This point of activation is determined and set at the factory for maximum efficiency of the drive system; altering spring preload, centrifugal weights, or ramp angle, without attention to manufacturer recommendations for altitude, trail conditions, and carburetor tuning, can affect the efficiency of the drive system.

PAGE 72, V. Lubrication and cleaning

A. Many snowmobiles feature clutches with synthetic fiber bushings which require no lubrication

B. Always follow manufacturer specifications for lubricating the moving components of the drive clutch.

PAGE 72, VI. Clutch adjustment

D. Improper alignment can result in improper belt wear and damage, and significant reduction in the amount of horsepower delivered to the track.

PAGE 74, VIII. Troubleshooting

C. There are five precautions which must be taken in troubleshooting:

PAGE 76, IX. Clutch timing

B. Weights attached to the spider or the moving sheave control rpm through the complete shifting process:

1. Light weights cause a higher engine rpm to be needed for initial clutch engagement , and a slightly higher engine rpm for any given vehicle speed.

2. Heavy weights lower the engine rpm for initial clutch engagement and cause lower engine rpm at any given vehicle speed.

C. Ramps attached to the moving sheave affect engagement, mid-range shifting and full shifting.

1. A steep ramp angle will significantly increase engine rpm.

2. A more gradual incline in ramp angle will decrease engine rpm.

PAGE SR-389, II. **Snowmobile electrical requirements**

A. The two basic electrical needs on a snowmobile are:

1. An ignition system to ignite the fuel/air mixture
2. An electrical system to operate lights and other accessories

PAGE SR 391, IV. **Battery service**

H. After adding distilled water, charge the battery at a rate equal to 10% of the battery amp hour rating so the water will mix thoroughly and until the electrolyte specific gravity is 1.260+, to keep the electrolyte from freezing. A higher charging rate could damage the battery.

PAGE SR 391, V. **Magneto ignition systems**

B. Magneto ignition systems may be an energy transfer type. Timing is accomplished with breaker points and a condenser, and are serviced like other breaker point/condenser systems.

PAGE SR-393, **Spark plug service**

C.

3. Gray or brownish stains on the outer surface of the insulator near the shell indicate a cylinder gas leak and/or electrical corona discharge.

PAGE 132, III Transmission principles

G. The sheaves of the two clutches are moved laterally to change the effective diameter of the clutch.

PAGE 206, IV. Axle repair

A. Little maintenance is required of the axles except to see that bearings on the axles are properly lubricated and that the jack shaft is properly aligned. (See Unit V, Job sheet #2, Routine #2 and #3- Checking and adjusting center distance and parallelism).

B. Most drive axle bearing on the chain case side are lubricated by the chain case lubricant.

C. Most drive axle bearing opposite the chain case side are sealed bearings and can not be serviced, these must be replaced if found defective.

D. Occasionally the drive axle shaft may be bent by impact with hard objects at fast speeds and may require replacement.

E. Missing track inserts can cause chipped or broken teeth on drive sprockets.

F. Track misalignment can cause excessive wear to the sprockets, the track, and bearings.

PAGE 318, IV. Types of snowmobile brakes

B. Self-adjusting cable-operated disc brakes are similar to the manual disc brakes except the system uses ratcheting-type gear to maintain proper clearance between the pad and the disc as the pad wears.

C. Hydraulic brake systems also use pads but the pads are activated by hydraulic pressure. The hydraulic pressure is developed by movement of the brake hand lever which pressurizes hydraulic fluid in the master cylinder. The hydraulic pressure is transferred via the brake tubing to the caliper housing, causing the caliper piston to move and the pads to contact the disk.

PAGE 350, VIII. Types of carburetors

A. Snowmobile carburetors are identified as either a float type or diaphragm type and by throttle valve design.

B. Throttle valve design may be:

1. Butterfly throttle valve
2. Slide valve throttle

PAGE 350, XI Coolant/Antifreeze

A. Liquid-cooled snowmobiles require the use of a mixture of water and ethylene-glycol antifreeze which protects the mixture from boiling up to 264$^{O}$F and from freezing down to -34$^{O}$F.

**PAGE SR-47**

**Add the following note at the bottom of PAGE SR-47**

(Note: Apply a thread sealing adhesive,LOCTITE™ or similar to tie rod threaded components upon reassembly)

**PAGE SR-239 Unit VIII, Job sheet #1**

**Add the following note below item B.3. on PAGE SR-239**

**(CAUTION: Release tension on front and rear suspension adjustment springs by unhooking springs from rear and forward arm brackets. Use appropriate tool to hold spring and release tension gradually keeping hands and fingers away from spring ends and suspension parts until spring tension is released.)**

**PAGE SR-275 Unit IX, Job sheet #2**

4. Inspect the distance...

   c. If alignment is correct, then check the track tension again, making tension adjustment if necessary, tighten adjuster bolt jam nuts.

**Add the following note below item 5. on PAGE SR-275**

(NOTE: On a properly tensioned track, the track should be able to be rotated by hand. If the track can not be moved by hand, the tension is too tight or other drive components are not functioning properly.)

**PAGE SR-279, Unit IX, Job sheet #4**

B. Procedure...

5. Remove worn clips by drilling a series of indentations across each clip or grinding an indentation with a die grinder, and splitting the clips open with a hammer and chisel.

   (NOTE: There is no need to drill all the way through the clip: short holes will be sufficient to cause the clips to split.)

6. Compress new clips onto the track with the manufacture's special installation tool.

   (NOTE: Installation of new clips without the use of the manufacturer's recommended tool is not advised, as proper installation can not be achieved without it.

7. Rotate the track until all worn or missing clips have been replaced.

   (NOTE: If there is inadequate clearance to perform the above procedure with the suspension in place, the suspension should be removed.)

PAGE 56

Add the following note below item 16. on PAGE SR-56

(Note: Apply a thread sealing adhesive,LOCTITE™ or similar to tie rod threaded components upon reassembly)

PAGE 216, **Unit VII, Job sheet #2**

Add the following note below item 16 on PAGE 216

(Note: Do not clean sealed bearings in solvent. If the bearing is useable, the solvent may leak into the bearing and compromise the lubricating grease installed during manufacture. If the sealed bearing does not turn freely and smoothly, it is defective and must be replaced).

PAGE 404, **Unit XIII, Job sheet #1**

D. Routine #3-...

6. Check the battery ampere-hour rating on the battery case, and charge the battery at a rate of 10% of that rating. A higher charge rate could damage the battery.

**PAGE SR-369, Unit XII, Job sheet #1**

F. Routine #5-...

15. Stop the engine.

**PAGE SR-411, Unit XIII, Job sheet #3**

Add the following note below item B. 5. on PAGE SR-411

(NOTE: It is not recommended to use sand-blast type abrasive spark plug cleaners. Some manufacturers will void the warranty on their engine if a sand -blasted spark plug is installed in it. It has been shown that it is difficult to remove all of the sand in the plug and an engine can be ruined by only a little sand.

PAGE SR-27, **ANSWERS TO TEST** (Unit I)

7. a. 1) Piston
   3) Rod
   b. 1) Carburetor
   3) Ignition
   4) Fuel
   5) Lubrication
   6) Exhaust

PAGE SR-97 **ANSWERS TO TEST** (Unit III)

5. a. Synthetic fiber

PAGE SR-129, **CONTENTS OF THIS UNIT**, (UNIT V)

F. Job sheets

1. Job Sheet #1 - Remove, inspect, and replace a driven clutch

2.. Job Sheet #2 - Check and adjust offset, center distance and parallelism on a snowmobile transmission

PAGE SR-223, **ANSWERS TO TEST** (Unit VII)

Delete item 4.a. as a correct answer.

PAGE SR-341, **ANSWERS TO TEST** (Unit XI)

Delete item 4.c. as a correct answer.

PAGE SR-361, **ANSWERS TO ASSIGNMENT SHEET** (Unit XII)

D. The three types of carburetors are identifiable as a float type with a butterfly throttle valve, a float type with a slide valve throttle, and a diaphragm type carburetor.

PAGE 64, **ANSWERS TO TEST** (Unit II)

9. a,b,c,e,g

Note: delete 9.h as a correct answer choice

PAGE 384, **ANSWERS TO TEST** (Unit XII)

8. a. Float, diaphragm
   b. 1) Butterfly throttle
      2) Slide valve

PAGE SR-165, **TEST** (Unit V)

3. Complete statements...

g. The sheaves of the two clutches are moved laterally to change the effective **(angle, diameter)** of the clutch.

PAGE SR-219, **TEST** (Unit VII)

1. Match terms...

_____a. A solid or semi-solid shaft of steel which connects to the drive chain by a sprocket and drives the track.

PAGE SR-381, **TEST** (Unit XII)

11. Select true statements...

____a. Liquid-cooled snowmobiles require the use of a mixture of water and ethylene-glycol antifreeze which protects the mixture from boiling up to 264$^{O}$F and from freezing down to -34$^{O}$F.

PAGE 22 , **Test** (Unit I)

7. Complete statements...

   b. Other systems and components of a snowmobile engine include:

      1. The _____

      2. The cooling system

      3. _____ systems and spark plugs

      4. Carburetion and _____system

      5. _____system (pre-mix or injection system)

      6. An _____ system

PAGE 92, **TEST** (Unit III)

5. Complete statements concerning lubrication and cleaning by inserting the word(s) that best completes each statement.

   a. Many snowmobiles feature clutches with _____ bushings which require no lubrication

   b. Always follow _____ specifications for lubricating the moving components of the drive clutch.

6. Complete statements...

   d. Improper alignment can result in improper belt wear and damage, and significant (**increase, reduction**) in the amount of horsepower delivered to the track.

PAGE 380, **TEST** (Unit XII)

8. Complete statements...

   a. Snowmobile carburetors are identified as either a_____ type or _____ type and by throttle valve design.

   b. Throttle valve design may be:

      1. _____ _____ valve

      2. _____ throttle